10/743943 Segway

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L12	L10 and (segway$ or Centaur or (human$ with ransport$)) and ("two-wheel" or (two adj wheel$))	0	L12
L11	L10 and (segway$ or Centaur or (human$ adj2 transport$)) and ("two-wheel" or (two adj wheel$))	0	L11
L10	L2 and ((detect$ or sens$) with (malfunction$ or abnormal$))	117	L10
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L8	L5 and ((detect$ or sens$) with abnormal$)	0	L8
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L6	L5 and (first$ with driv$) and (second$ with driv$)	10	L6
L5	l3 or L4	37	L5
L4	(segway$ or Centaur or (human$ adj2 transport$)) and ("two-wheel" or (two adj wheel$)) and @pd<=20021227	20	L4

L3	(segway$ or Centaur or (human$ adj2 transport$)) and ("two-wheel" or (two adj wheel$)) and @ad<=20021227	35	L3
L2	(segway$ or (human$ adj2 transport$)) and @ad<=20021227	1312	L2
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L1	6018694.pn.	1	L1

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       06nov06 14:04:05 User264717 Session D528.1
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     $0.05  INTERNET
     $0.05  Estimated cost this search
     $0.05  Estimated total session cost   0.323 DialUnits

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>>>File 63 processing for PD=  : PD=021227
>>>    started at PD=DATED stopped at PD=19680517
>>>File 81 processing for PD=  : PD=021227
>>>    started at PD=19390728 stopped at PD=19920325
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              91  SEGWAY
            1074  CENTAUR
         1966245  HUMAN?
         1024249  TRANSPORT?
            2815  HUMAN?(3W)TRANSPORT?
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                  TRANSPORT?)
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S S1 AND (DETECT? OR SENS? OR CHECK?) (3W) (MALFUNCTION? OR ABNORMAL? OR FUNCTION?))
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          155957  CHECK?
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          152325  ABNORMAL?
         1989787  FUNCTION?
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                  OR ABNORMAL? OR FUNCTION?))
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RD
      S3   5 RD (unique items)
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T S3/3,KWIC/1-5

3/3,KWIC/1 (Item 1 from file: 6)
DIALOG(R)File 6:NTIS

1095927 NTIS Accession Number: AD-P002 719/3
Certification Experience with Methods for Minimum Crew Demonstration
Speyer, J. J. ; Fort, A.
Airbus Industrie, Blagnac (France). Flight Div.
Corp. Source Codes: 075534001; 414441
Oct 83 30p
Languages: English
Journal Announcement: GRAI8410
This article is from the Proceedings of the Conference on Flight Mechanics and System Design Lessons from Operational Experience Held in Athens, Greece on 10-13 May 83, AD-A137 607, p26-1 - 26-31.
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NTIS Prices: PC A03/MF A01

... INDUSTRIE's human factors involvement in flight tests and certification with the double objective of checking functional effectiveness of the man-machine system and human welfare in its utilization process. The crew...

3/3,KWIC/2 (Item 2 from file: 6)
DIALOG(R)File 6:NTIS

1095923 NTIS Accession Number: AD-P002 715/1
New Flight Deck Design in the Light of the Operational Capabilities
Seifert, R. ; Brauser, K.
Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Military Aircraft Div.
Corp. Source Codes: 064776007; 414445
Oct 83 13p
Languages: English
Journal Announcement: GRAI8410
This article is from the Proceedings of the Conference on Flight Mechanics and System Design Lessons from Operational Experience Held in Athens, Greece on 10-13 May 83, AD-A137 607, p21-1 - 21-13.
Order this product from NTIS by: phone at 1-800-553-NTIS (U.S. customers); (703)605-6000 (other countries); fax at (703)321-8547; and email at orders@ntis.fedworld.gov. NTIS is located at 5285 Port Royal Road, Springfield, VA, 22161, USA.
NTIS Prices: PC A02/MF A01

... performance. Introduction of 'fail safe and fail ops. ergonomic design' by means of H.E. detection and correction functions designed into the man-machine interface intelligence. The last generations of aircraft are compared regarding...

3/3,KWIC/3 (Item 3 from file: 6)
DIALOG(R)File 6:NTIS

0592962 NTIS Accession Number: AD-843 194/2/XAB
Pre-Production Test Report for Solenoid Sensor, Dwg. No. 27-81448-807, and -813
Sproles, S. G.
General Dynamics/Astronautics San Diego Calif
Corp. Source Codes: 147550
Report No.: GDA-27A675
8 Mar 61 121p
Journal Announcement: GRAI7704
Distribution limitation now removed. Order this product from NTIS by: phone at 1-800-553-NTIS (U.S. customers); (703)605-6000 (other countries); fax at (703)321-8547; and email at orders@ntis.fedworld.gov. NTIS is located at 5285 Port Royal Road, Springfield, VA, 22161, USA.
NTIS Prices: PC A06/MF A01

Pre-production testing was performed on two solenoid sensor assemblies. The prime function of the solenoid sensor is to regulate and maintain the liquid oxygen boiloff valve (P...

... to be used on the 'F' series Atlas, extra heavy agena booster, and the Atlas - Centaur booster. When incorporated with the boiloff valve, and properly adjusted, the solenoid sensor is designed...

3/3,KWIC/4 (Item 1 from file: 63)
DIALOG(R)File 63:Transport Res(TRIS)

00967039 DA
TITLE: PSYCHOLOGICAL ISSUES OF AGING INDEPENDENTLY. IN: AGING INDEPENDENTLY. LIVING ARRANGEMENTS AND MOBILITY
AUTHOR(S): Kruse, A
CORPORATE SOURCE: Springer Publishing Company, 536 Broadway, New York, NY, 10012-,
Pag: pp 46-61
PUBLICATION DATE: 20030000 PUBLICATION YEAR: 2003
LANGUAGE: English SUBFILE: HRIS (H)
ISSN: N/A ISBN: 0826118542
AVAILABILITY: Springer Publishing Company; 536 Broadway ; New York; NY ; 10012-
ORDER NUMBER: N/A
TABLES: 4 Tab.
REFERENCES: Refs.

...ABSTRACT: behavior schemata, the compensation of developmental losses, and the effects of stimulation and training on sensorimotor and cognitive functioning . The next section proceeds from a multidimensional model of cognitive structure and development. It is...
DESCRIPTORS: Aging (Biology); Aged; Mobility; Accessibility; Psychological aspects; Human factors; Transportation planning; Independence

3/3,KWIC/5 (Item 1 from file: 95)
DIALOG(R)File 95:TEME-Technology & Management

01419575 20000602186

Improvement of crowd management through an automatic queue length measurement

Aubert, D
INRETS, Arcueil, F

ETT 99 / SATNAV 99, 1st European Symposium on Transport Telematics, Potsdam, D, 8.-12. Nov, 19991999
Document type: Conference paper Language: English
Record type: Abstract

ABSTRACT:
...developed to improve the quality of service in public transport. These systems encompass various incident detections (such as abnormal station conditions, counter-flow, peopole falling on the track) and crowd measurements (such as people...

DESCRIPTORS: IMAGE CONTRAST; COMPUTERISED PICTURE PROCESSING; GRAY LEVEL; HUMANS ; PERSONAL TRANSPORT ; CONTROL SYSTEMS; VIDEO TECHNIQUE; QUEUE...
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Set     Items   Description
S1       3889   PD<=021227 AND  SEGWAY OR CENTAUR OR (HUMAN? (3W) TRANSPOR-
            T?)
S2          5   S1 AND ((DETECT? OR SENS? OR CHECK?) (3W) (MALFUNCTION? OR
             ABNORMAL? OR FUNCTION?))
S3          5   RD  (unique items)
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L6: Entry 1 of 10 File: PGPB Aug 21, 2003

PGPUB-DOCUMENT-NUMBER: 20030156930
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030156930 A1

TITLE: Vehicle article carrier

PUBLICATION-DATE: August 21, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Ahedo, Artie A. JR.	Tampa	FL	US

APPL-NO: 10/080133 [PALM]
DATE FILED: February 21, 2002

INT-CL-PUBLISHED: [07] B60P 9/00

INT-CL-CURRENT:

TYPE	IPC	DATE
CIPS	A61 G 3/00	20060101
CIPS	A61 G 3/02	20060101
CIPS	B60 P 3/06	20060101

US-CL-PUBLISHED: 414/462; 224/521, 414/540
US-CL-CURRENT: 414/462; 224/521, 414/540

REPRESENTATIVE-FIGURES: 2

ABSTRACT:

An article carrier for a vehicle is attachable to a rear mounted vehicle attachment, such as an elevatable lift attachment. The article carrier includes a tray having at least one article receiving track mounted therein for receiving an article. The tray is affixable to the vehicle attachment. A cover is movably mounted on the tray for movement between a first closed position enclosing the tray and an article mounted thereon and a second, open position wherein the cover is spaced from the tray to expose substantially all of the tray for article loading and unloading. Article tie-downs are carried on the tray for securing an article mounted on the tray in a fixed, stationary position. Latches are provided on the cover and the tray for releasably latching the cover in the first closed position.

L6: Entry 2 of 10 File: PGPB Sep 5, 2002

PGPUB-DOCUMENT-NUMBER: 20020121394
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020121394 A1

TITLE: Control system and method

PUBLICATION-DATE: September 5, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Kamen, Dean L.	Bedford	NH	US
Ambrogi, Robert R.	Manchester	NH	US
Amsbury, Burl	Boulder	CO	US
Dastous, Susan D.	Windham	NH	US
Duggan, Robert J.	Stafford	NH	US
Heinzmann, John David	Manchester	NH	US
Heinzmann, Richard Kurt	Francestown	NH	US
Herr, David W.	Compton	NH	US
Kerwin, John M.	Manchester	NH	US
Morrell, John B.	Manchester	NH	US
Steenson, James Henry JR.	Derry	NH	US

APPL-NO: 09/930127 [PALM]
DATE FILED: August 15, 2001

RELATED-US-APPL-DATA:
Application 09/930127 is a continuation-of US application 09/321401, filed May 28, 1999, ABANDONED
Application is a non-provisional-of-provisional application 60/124403, filed March 15, 1999,

INT-CL-PUBLISHED: [07] B60G 23/00

INT-CL-CURRENT:

TYPE	IPC	DATE
CIPS	A61 G 5/06	20060101
CIPN	A61 G 5/04	20060101
CIPS	G05 B 13/04	20060101
CIPS	A61 G 5/00	20060101

US-CL-PUBLISHED: 180/41
US-CL-CURRENT: 180/41

REPRESENTATIVE-FIGURES: 2A

ABSTRACT:

Systems and methods for controlling a device are disclosed. In one embodiment, the systems and methods allow for the control of a human transport device such that the human transport device remains in an upright position regardless of the surface being traversed. The systems and methods may include a plurality of operational modes where each mode has different characteristics. Additionally, systems and method for locating a center of gravity of a device are disclosed.

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The application is a continuation of U.S. application Ser. No. 09/321,401, filed May 28, 1999, which claims the benefit of prior filed provisional application number 60/124,403, filed Mar. 15, 1999 and entitled Control Modes for a Personal Vehicle, which is incorporated herein by reference.

Previous Doc Next Doc Go to Doc#

L6: Entry 1 of 10 File: PGPB Aug 21, 2003

DOCUMENT-IDENTIFIER: US 20030156930 A1
TITLE: Vehicle article carrier

Application Filing Date:
20020221

Summary of Invention Paragraph:
[0001] The present invention relates, in general, to vehicle article carriers, and more particularly, to article carriers which are mounted on a vehicle for carrying human transport vehicles.

Summary of Invention Paragraph:
[0006] The present invention is an article carrier for mounting on a rear vehicle trailer mount. The article carrier is configured for easily carrying diverse articles, such as wheelchairs, bicycles, strollers, motorcycles and other human transport vehicles.

Detail Description Paragraph:
[0026] The enclosure 12 is configured of a size and shape for receiving many diverse articles. Thus, it will be understood that the enclosure 12 can receive many different articles, not just the human transport vehicles, such as a manually operated, collapsible wheelchair or a powered wheelchair which is described and illustrated hereafter. For example, in addition to wheelchairs, the enclosure 12 can be modified in size to handle a two wheel, gyroscopically stabilized human transport sold by Segway. Other articles which can be mounted in the enclosure 12 include motor cycles, bicycles, strollers, baby carriages, etc.

Detail Description Paragraph:
[0032] For example only, the vehicle attachment 14 has a manually operated or motor powered drive to elevate the arm and the attached tray 22 between a first elevated or raised, vehicle movable position shown in FIG. 1 and second, lowered, article loading and unloading position shown in FIGS. 3 and 5. An example of such a powered is a lift sold by Renfroematics as the Rise & Ride, serial no. A:4175.

Detail Description Paragraph:
[0050] In addition to the limit stops described above, a power drive means, such as motor drive jack screw(s) may be mounted between the tray 22 and the cover 20 to facilitate an automatic, powered movement of the cover 20 relative to the tray 22 between the first and second or open or closed positions. Electric power for the drive motor can be obtained from the powered lift 14 and controlled by a switch on the lift 14 or from a remote control, hand held transmitter.

Detail Description Paragraph:
[0056] In summary, there has been disclosed a unique article carrier mounted on a rear attachment for a vehicle which enables articles, such as movable wheelchairs, bicycles, motorcycles, strollers, baby carriages and other human transport vehicles, to be easily loaded and unloaded on the vehicle for transport between various locations. The article carrier is formed of weather resistant material for long reliable use. The unique article tie downs in the carrier ensure that the articles in the carrier are held in a stationary position during movement of the

vehicle. The tray of the article enclosure may be reconfigured as necessary to support a variety of diverse articles having different wheel arrangements.

Previous Doc Next Doc Go to Doc#

L6: Entry 2 of 10 File: PGPB Sep 5, 2002

DOCUMENT-IDENTIFIER: US 20020121394 A1
TITLE: Control system and method

Abstract Paragraph:
Systems and methods for controlling a device are disclosed. In one embodiment, the systems and methods allow for the control of a human transport device such that the human transport device remains in an upright position regardless of the surface being traversed. The systems and methods may include a plurality of operational modes where each mode has different characteristics. Additionally, systems and method for locating a center of gravity of a device are disclosed.

Pre-Grant Publication Date:
20020905

Application Filing Date:
20010815

Summary of Invention Paragraph:
[0005] Human transport devices serve to move a person over a surface and may take many different forms. For example, a human transport device, as the term is used herein, may include, but is not limited to, wheelchairs, motorized carts, bicycles, motorcycles, cars, hovercrafts, and the like. Some types of human transport may include stabilization mechanisms to help ensure that the device does not fall over and injure the user of the transport device.

Summary of Invention Paragraph:
[0007] Referring now to FIG. 1A, a typical wheelchair 100 is shown. The wheelchair 100 and the user 102 define a frame. The frame has a center of gravity 104 located at a position vertically disposed above the surface 106. The term "surface" as it is used herein shall refer to any surface upon which a human transport device may sit. Examples of a surface include flat ground, an inclined plane such as a ramp, a gravel covered street, and may include a curb which vertically connects two substantially parallel surfaces vertically displaced from one another (e.g., a street curb).

Summary of Invention Paragraph:
[0009] The front wheel 112 and the rear wheel 110 of the wheelchair 100 are separated by a distance d. The distance d between the two wheels may be measured as a linear (e.g., straight line) distance. If the center of gravity 104 of the system is located at a position above and between the two wheels, 110 and 112, the wheelchair 100 should remain upright and relatively stable. The wheels 110 and 112 typically have opposing counterparts (not shown) on the other side of the wheelchair. The opposing counterparts may each share an axis with wheels 110 and 112, respectively. The area covered by the polygon which connects the points where these four wheels touch the ground (or the outside portions of the ground contacting parts, when the ground contacting part may cover more than a point) provides an area over which the center of gravity 104 may be located while the wheelchair remains stable. In various places in this discussion below this area may be referred to as the footprint of the device. The footprint of a device, as the term is used herein, is defined by the projection of the area between the wheels as

projected onto the horizontal plane. If the center of gravity is above this location, the transport device should remain stable.

Summary of Invention Paragraph:
[0011] The user 102 may help to return the center of gravity 104 to a location that is above the area between the wheels 110 and 112 by leaning forward in the wheelchair 100. Given this limited control of the location of the center of gravity 104, it is clear that human transport devices such as wheelchairs may encounter great difficulties when traversing uneven surfaces such as a curb or steps.

Summary of Invention Paragraph:
[0012] Other types of human transport devices may include control mechanisms which allow the transport device to balance on two wheels. The two wheels may be connected to a single3 axis that passes through the center of the wheels. The axis connects the wheels in such a manner that the forward and backwards motion of the device is perpendicular to the axis. The control mechanisms may keep the device and the user in a stable upright position by driving the wheels forwards and backwards to keep the center of gravity located over the wheel axis. Such devices may additionally provide for locomotion by allowing the center of gravity to be displaced by a distance forward or backwards from wheel axis and having the wheels rotate in order keep the center of gravity located at that position. Examples of such devices are disclosed in U.S. Pat. Nos. 5,701,965 and 5,719,425 which are hereby incorporated by reference.

Summary of Invention Paragraph:
[0013] According to one embodiment of the present invention, a self balancing human transport device is disclosed. According to this embodiment, the transport device includes a movable arm and a ground contacting member coupled to the moveable arm. The transport device also includes a control unit to control movement of the arm in order to balance the transport device and to control movement of the ground contacting member in order to balance the transport device.

Summary of Invention Paragraph:
[0014] According to another embodiment of the present invention, a method of controlling a human transport device is disclosed. According to this embodiment, the method includes a step a) of moving an arm in order to balance the transport device. The method also includes a step b) of during step a) moving a ground contacting member in order to balance the transport device.

Summary of Invention Paragraph:
[0015] According to another embodiment of the present invention a human transport device capable of operating in a plurality of operational modes is disclosed. In this embodiment the transport device includes a rotatable cluster that has at least one ground contacting member and at least one actuator to move the cluster and the ground contacting member. In this embodiment the transport device also includes a control unit that provides a control signal to the actuator, the control unit providing the control signal such that the actuator causes both the cluster to rotate and the ground contacting member to move such that a center of gravity of the human transport device is located at a position vertically displaced between endpoints of the cluster.

Summary of Invention Paragraph:
[0017] In another embodiment of the present invention a method of controlling a transport device having a human occupant, the transport device having a cluster with wheels attached thereto and having a footprint whose area is greater than about zero is disclosed. In this embodiment the transport device is controlled by simultaneously controlling a position of the cluster and a position of the wheels such that a center of gravity of the transport device having a human occupant is located toward a center of the footprint of the transport device.

Summary of Invention Paragraph:
[0020] In another embodiment of the present invention, a human transport device operating in a plurality of modes is disclosed. In this embodiment, the transport device includes a control unit that changes a current operational mode of the transport device automatically, depending upon operational characteristics of the transport device.

Summary of Invention Paragraph:
[0023] In another embodiment of the present invention, a human transport device that returns to a stable state after a disturbance has been encountered such that a human user of the device remains in an upright position is disclosed. In this embodiment, the transport device includes user input that receives user-desired positional input commands, and a control unit that varies the responsiveness of the human transport device to the user input commands based upon a current orientation of at least one portion of the transport device.

Summary of Invention Paragraph:
[0025] In another embodiment of the present invention a transport device is disclosed. In this embodiment, the human transport device includes a plurality of ground contacting members that may be moved in order to balance the transport device and a gain table containing at least two sets of gain coefficients. In this embodiment, the transport device also includes a control unit that applies one of the at least two sets of gain coefficients to inputs to the control unit in order to create a control signal which controls the movement of the wheels. In this embodiment, the set of gains applied by the control unit may vary automatically during the operation of the transport device.

Summary of Invention Paragraph:
[0026] According to another embodiment of the present invention a method of keeping a human transport device in an upright position as the transport device traverses uneven surfaces is disclosed. In the embodiment, the method includes steps of receiving user inputs, determining a current orientation of at least one portion of the transport device, and selectively applying different gain coefficients to the inputs based on the current orientation of the at least one portion of the transport device.

Summary of Invention Paragraph:
[0027] In another embodiment of the present invention a control system for controlling a human transport device is disclosed. In this embodiment, the control system includes a control unit that adjusts a cluster and at least one ground contacting member of the transport device such that a center of gravity of the transport device remains substantially vertically displaced over a location between end points of the cluster.

Summary of Invention Paragraph:
[0028] In another embodiment of the present invention, a method of switching between a plurality of modes in a human transport device is disclosed. In this embodiment, the method includes steps of determining a first value that represents a position of a center of gravity of the transport device, and selecting between two of the plurality of modes based upon the value.

Brief Description of Drawings Paragraph:
[0033] FIGS. 2A-2F illustrate various embodiments of a human transport device.

Brief Description of Drawings Paragraph:
[0034] FIG. 3 illustrates another embodiment of a human transport device.

Brief Description of Drawings Paragraph:
[0036] FIGS. 5A and 5B illustrate the relative orientation of a cluster of a human transport device operating in a stair mode.

Brief Description of Drawings Paragraph:
[0037] FIG. 6 illustrates a block diagram of possible operational modes of a human transport device.

Detail Description Paragraph:
[0061] Aspects of the present invention relate to various control modes for the operation of a human transport device. Each of the various modes allow for different types of control. In some embodiments, some of the modes are very responsive to user input commands while others may entirely ignore user input commands in an effort to keep the transport device and, ultimately, the user in an upright and stable position.

Detail Description Paragraph:
[0062] FIG. 2A shows an example of a transport device 200 in which aspects of the present invention may be implemented. Note that various aspects of the invention will be described in relation to various transport devices, however, the teachings herein are not limited to implementation only in human transport devices. For example, various control modes may be applicable to transport devices that are not similar to the transport device 200 shown in FIG. 2A. In addition, the systems and methods that allow for smooth transitions between the various modes may be applicable to other devices.

Detail Description Paragraph:
[0065] The transport device 200 may also include ground contacting members 208 and 210. As shown in FIG. 2A the ground contacting members 208 and 210 are wheels. However, it should be noted that the ground contacting members 208 and 210 are not limited to wheels. For instance, the ground contacting members could be a caster, a rigid member (e.g., such as the arcuate elements shown in FIGS. 22-24 of U.S. Pat. No. 5,791,425), treads or other mechanisms for locomotion. Human transport devices having these and other types of ground contacting members are discussed below.

Detail Description Paragraph:
[0067] The wheels, 208 and 210, may be attached to a moveable arm 212 (or cluster). The terms moveable arm and cluster, as used herein shall refer to an assembly to which ground contacting members may be attached. In addition, the cluster may from time to time refer to the entire assembly which includes and connects the ground contacting members together depending on the context. The cluster 212 may be a rigid member or may be a member that may be folded around various axes. For example, referring now to FIG. 2B where a cluster 214 is shown having a first portion 216 and a second portion 218, the first portion 216 and the second portion 218 may be pivotally attached to one another at a pivot point 220. The cluster 214 may include two wheels 222 and 224. The two wheels, 222 and 224, may contact the surface at contact points 226 and 228, respectively. The distance between contact point 226 and contact point 228 define the length (l) of the footprint of the transport device in this embodiment because the cluster is on a horizontal plane. (Of course, if the cluster was on an incline, the length of the footprint would be equal to the length of the projection of L onto the horizontal plane.) The length (l) of the footprint is variable in this embodiment due to the pivot point 220 between the first portion 216 and the second portion 218 of the cluster 214. The length (l) of the footprint is at its largest when the angle .theta..sub.c between the first portion 216 of the cluster 214 and the second portion 218 of the cluster 214 is approximately 180.degree..

Detail Description Paragraph:
[0073] FIG. 2D shows an alternative embodiment of a cluster 248 for a human transport device 200. In this embodiment, the cluster 248 includes a first wheel 250 that may be driven by a motor (not shown). The commands which drive the motor may be received from the control unit 240 (FIG. 2A). The cluster 248 may also include a second wheel 252 which is not driven by a motor. For example, the second

wheel 252 may be a caster type wheel which is fixedly attached to the cluster 248. Although the previous figures have described with the direction of forward travel being from left to right, it should be understood that the cluster 248 of FIG. 2D may be oriented in either direction. That is, the motorized wheel 250 may be the front wheel or the second wheel 252 may the front wheel.

Detail Description Paragraph:
[0076] The foregoing discussion detailed various embodiments of a human transport device 200. It should be noted that the wheels 208 and 210 may be motorized wheels that are each driven by an individual motor. However, the wheels 208 and 210 may both be driven by a single motor. In addition, only one of the wheels may be driven by a motor. Furthermore, the transport device 200 has been shown only in side view. It should be understood that elements shown in side view may be mirrored on the other side of the transport device 200. For instance, the transport device may include a cluster on each side of the transport device 200. In one embodiment the clusters may be statically linked together so that they move as a unitary member. However, it is within the scope of the present invention that the clusters may be rotated or otherwise translated such that each cluster operates independently from the other. It should further be noted that the present invention is not constrained to being implemented in the transport devices described above. For instance, portions or the entirety of the teachings contained herein may be implemented in transport devices such as helicopters, airplanes, automobiles, off-road vehicles, motorized bicycles, motorcycles, and the like. Another type of transport device in which the teachings of the present invention may be implemented is shown in FIG. 3.

Detail Description Paragraph:
[0077] FIG. 3 shows a human transport device 300 upon which a user may stand. The transport device may include a platform 302 suitable for supporting a human user 304 in a standing position. In one embodiment, the motion of the device 300 may be controlled by the human 302 leaning on the platform 302 in the desired direction of motion. In this embodiment, the platform 302 may be pivotally attached to a base unit 306. The base unit 306 may include a control unit 308 which may control the motion and, possibly, the stabilization of the transport device 300. The base unit 306 may also include a cluster 310 which includes ground contacting members such as wheels 312 and 314. The human transport may also include a second user input device such as a joystick 316 for receiving desired motion commands from the user. As shown in FIG. 3, the human transport device 300 includes both a lean platform 302 and a joystick 316.

Detail Description Paragraph:
[0081] Again, the transport device 200 in balance mode, operates by controlling the position of the platform 202 so that the center of gravity 400 is vertically displaced at some location above the transverse axis 402 of the surface contacting wheel 404 upon which the transport device 200 is resting. To allow for motion, the center of gravity 400 may be slightly displaced either in front of or behind the transverse axis 402 of surface contacting wheel 404 so that the device begins a controlled fall in the "FORE/AFT" direction. As the center of gravity 400 is displaced relative to the transverse axis 402, the surface contacting wheel 404 is driven to, in essence, keep the center of gravity 400 in a relatively close, but still offset, location as compared to the axis 402. In this manner, the device does not fall over. Balance mode for a transport device such as that shown in FIG. 4 is disclosed in U.S. Pat. No. 5,701,965. In this embodiment for balance mode, the cluster 406 is locked in position and may not be rotated in order to help stabilize the transport device 400. Thus, in this embodiment, balance mode may be generally thought of as a "wheels only" approach to dynamically stabilizing a human transport device.

Detail Description Paragraph:
[0082] In some instances, it may be desired to have a human transport device climb

or descend stairs with little or no assistance from the user or any other outside help. Thus, some human transport devices have developed the capability to climb stairs and operate in a so called "stair" or "lean" mode. Examples of such devices are shown U.S. Pat. Nos. 5,701,965 and 5,791,425. Stair mode may include having the wheels "slaved" to the cluster. That is, the wheels may only move in order to allow the cluster to rotate but not as a means of locomotion.

Detail Description Paragraph:
[0083] FIGS. 5A and 5B show two examples of the relative orientation of a cluster 500 of a human transport device operating in stair mode. When operated in stair mode, the cluster 500 may be rotated so that the center of gravity is over either a rear wheel axle or front wheel axle depending upon which direction the stairs are being traversed (i.e., whether going up or down stairs). When the wheel 502 contacts the front edge 506 of a stair 508 the wheel is held against the stair. As the center of gravity is moved toward the contact point 514, the cluster 500 may begin to rotate upward as shown in FIG. 5B. As the cluster 500 is rotated, the slaved wheel 502 may be rotated in relation to the cluster 500 in response to the cluster rotation so that the same point on the wheel remains in contact with the stair at contact point 510. If the wheel 502 was allowed to move, the rotation of the cluster may cause the wheel 502 to move away from the step and cause the transport device to fall over.

Detail Description Paragraph:
[0087] FIG. 6 is a block diagram detailing possible operational modes of a human transport device. In one embodiment, the human transport device may include a standard mode 602, a balance mode 604, and a stair mode 606. According to aspects of certain embodiments of the present invention, the transport device may also include an enhanced mode 608. These various control modes are used by software and hardware contained in a control unit in order to provide locomotion for the device. Each mode causes the human transport device to operate according to different parameters. It should be noted that human transport devices may include other operational modes. For example, a human transport device may include a mode for transferring between modes and a mode for dealing with system failures.

Detail Description Paragraph:
[0088] The control modes and associated software and hardware discussed herein may be included in a control unit, such as the control unit described above with respect to FIG. 3. However, the various portions of the software and hardware may utilized in locations other than a control unit. For instance, various sensors could be located on the platform, the cluster, the wheels, or any other location where they may be desired or needed in order to effectively control the operation of a human transport device.

Detail Description Paragraph:
[0090] Standard mode, as the term is used herein, shall refer to a mode of operation where no dynamic stabilization occurs. In standard mode, the cluster and the platform remain in a fixed relationship to one another. For instance, if a user is operating a human transport device having a chair like platform (FIG. 2) in standard mode, a motor that controls the angle of platform relative to the cluster is held at a constant position. If the transport device is traversing up an incline, the platform tilts back. However, if the incline becomes too steep, the center of gravity of the system may lie in a location that is outside the footprint of the transport device and may cause the transport device to tip over backwards.

Detail Description Paragraph:
[0106] The reason that the seat height is important to the operation of the human transport device 700 is at least two-fold. First, the seat height H may be used in order to estimate the center of gravity 704 of the entire system. In addition, the seat height may affect how rapidly the center of gravity may be moving relative to a vertical axis defined by gravity (g). If the seat is higher, the center of

gravity may move slower in response to a disturbance. Thus, the seat height may be a variable considered when controlling the dynamic stabilization of the transport device. For instance, the seat height may be an input that affects the magnitude of particular gain coefficients (discussed below) that are utilized in order to control and otherwise stabilize the transport device.

Detail Description Paragraph:
[0114] As discussed above, in some circumstances providing only cluster stabilization routines may not effectively balance the transport device if the cluster displacement from vertical (i.e, (.phi..sub.c=0) becomes too small. In some embodiments, it is also possible to maintain balance by using the rotation of the wheels to help place the center of gravity above (or in an appropriate relation to) the footprint of the device. In addition, it has been discovered that balancing on two wheels may diminish the usability of the transport device. For instance by balancing only on two wheels, it may be difficult to negotiate over uneven surfaces. For example, to traverse up and over a curb on such a two wheel device, the amount of torque that needs to be applied to the wheels in order to essentially lift the transport device directly upwards may be excessive. When all of the torque is applied to raising the wheels up a vertical surface, the control required to keep the transport device in a substantially vertical position may be severely hampered.

Detail Description Paragraph:
[0118] FIG. 8 is an example of a control loop 800 that may be implemented in the present invention. The control loop 800 may include a plant 802 which may include, for example, a motor and a plurality of sensors that monitor various parameters of a transport device. At least one, and in some cases several, parameters may be fed-back from the plant 802 into the control loop 800. For example, the frame pitch 804 and the pitch rate 806 of a human transport device may be fed-back. Each of the parameters may be multiplied by a gain coefficient (e.g., gain coefficients 808a and 808b) in order to produce a control signal (the output of summer 810) that is ultimately again applied to the plant. The higher the value of the coefficient that a given parameter is multiplied by, the more that parameter effects the value of the control signal. Further examples of control loops which may be applied to a transport device are described in greater detail below (FIGS. 20 and 21).

Detail Description Paragraph:
[0143] The various switching processes described above, as well as various stabilization control within each mode, may be effected by driving both the wheels and the clusters of the transport device. Each wheel may be independently driven by a separate motor. Alternatively, some of the wheels may not be driven by a motor or two wheel attached to a common axis may be driven by a single motor. In addition, the cluster may include a separate motor.

Detail Description Paragraph:
[0173] As discussed above, the enhanced mode controller may switch between various modes. One of the reasons for switching between modes is to attempt to stabilize the human transport device. When transferring between sub-modes, the gains supplied to the control loops in the control unit may be changed or the control architecture itself may be changed. However, abruptly changing the gains or architecture may abruptly affect the operation of the transport device. This in turn may cause rapid acceleration of the center of gravity which will cause the transport device to become uncomfortable or even unstable. In addition, abrupt control changes (either gains or architectures) may increase wear on the system. Thus, there needs to be some method of smoothly transferring modes. The systems and methods described herein for smoothly transferring between modes of a system are effective in the context of controlling a human transport device. One of ordinary skill will realize that the teachings related to smooth modal transitions is not limited to application to human transport devices and may be applied to any multi-mode systems that transfers between modes. Thus, the following description will refer a "system"

instead of a human transport device. In some embodiments, the system may be a system that includes feedback from a controlled device, however, feedback is not necessary to control the scheduling discussed herein.

Detail Description Paragraph:
[0186] Based upon the current mode of operation, as represented in current mode data block 1714, a selector 1708 may choose whether to apply the coefficients for the first mode 1704 or the coefficients for the second mode 1706. The selector 1708 selects the correct coefficients and applies them as the control coefficients 1716 for the control unit 1702. The control coefficients may, for example, represent the current mode gain coefficient to be applied to the operation of a human transport device.

Detail Description Paragraph:
[0198] FIGS. 20 and 21 show example control loops for controlling the position of the clusters and the wheels of a transport device. These example control loops may be used to stabilize the human transport device. As one will readily realize, the control loops may be integrated into a single control loop that produces both cluster and wheel control commands. In addition, various portions of these control loops may be omitted and other portions may be added depending on the functional capabilities of the transport device. Furthermore, one of ordinary skill that the various control blocks discussed in relation to FIGS. 20 and 21 may be implemented in either hardware, software, or a combination of both.

Detail Description Paragraph:
[0230] The following description will detail how a center of gravity for a device may be estimated in order to determine desired orientations of components of a device. Although the center of gravity may be referred to in the context of a human transport device, it will be readily apparent that the teachings herein related to the estimation of a location the center of gravity is not limited to estimating the center of gravity for a transport device. As such, the following description will, in addition to referring to human transport devices, refer to any device where estimations of the center of gravity may be needed. Such devices will be referred to as systems in the forthcoming description.

Detail Description Paragraph:
[0234] The desired position determinator 2212 also receives the current mode 2213 of the system. In some systems, there may be different modes of operation which may use the estimate of the center of gravity in different manners. For instance, the device could be a human transporter that may self-stabilize in order to keep a user from falling off the transport device. In such systems, an estimate of the location of the center of gravity may be used in controlling the transport device such that the transport device is balanced. With reference again to FIG. 20, the estimate of the center of gravity may be used to determine the desired frame pitch of block 2046. How this estimate is determined and used is discussed below.

Detail Description Paragraph:
[0257] FIG. 26 is a graphical representation of the results of performing several iterations of the process outlined above. The horizontal axis represents the relative cluster orientation (.theta..sub.c) in radians and the vertical axis represents a corresponding electronics box orientation (.theta..sub.e) in radians which place the center of gravity over the footprint of the device (i.e., between the two wheels). Of course, a similar graphical representation could be created that relates .theta..sub.c to .phi..sub.c.

CLAIMS:

1. A self balancing human transport device comprising: a movable arm; a ground contacting member coupled to the moveable arm; and a control unit to control movement of the arm in order to balance the transport device and to control

movement of the ground contacting member in order to balance the transport device.

6. A method of controlling a human transport device comprising steps of: a) moving an arm in order to balance the transport device; and b) during step a) moving a ground contacting member in order to balance the transport device.

9. A human transport device capable of operating in a plurality of operational modes comprising: a rotatable cluster, the cluster having at least one ground contacting member; at least one actuator to move the cluster and the ground contacting member; and a control unit that provides a control signal to the actuator, the control unit providing the control signal such that the actuator causes both the cluster to rotate and the ground contacting member to move such that a center of gravity of the human transport device is located at a position vertically displaced between endpoints of the cluster.

11. The transport device of claim 10, wherein the transport device includes at least four wheels, and wherein a first two of the wheels are attached to the cluster on opposing sides of the transport device and have a first common axis which passes through the center of the first two of the wheels, and wherein a second two of the wheels are attached to the cluster on opposing sides of the transport device and have a second common axis which passes through the center of the second two of the wheels.

18. A method of controlling a transport device having a human occupant, the transport device having a cluster with wheels attached thereto and having a footprint whose area is greater than about zero, the method comprising steps of: simultaneously controlling a position of the cluster and a position of the wheels such that a center of gravity of the transport device having a human occupant is located toward a center of the footprint of the transport device.

26. A human transport device operating in a plurality of modes comprising: a control unit that changes a current operational mode of the transport device automatically, depending upon operational characteristics of the transport device.

27. The human transport device of claim 26, wherein the operational characteristics of the transport device includes a frame pitch, the frame pitch by which a frame which includes the human transport device and a user is displaced from a desired location.

28. The human transport device of claim 27, wherein the desired location is a location that places the center of gravity over a footprint of the human transport device.

29. The human transport device of claim 27, wherein the desired location is a location that places the center of gravity over a center point of a cluster of the human transport device.

30. The human transport device of claim 26, wherein the operational characteristics of the transport device includes a pitch rate, the pitch rate representing a rate at which a frame which includes the human transport device and a user is traveling with respect to gravity.

31. The human transport device of claim 30, wherein the pitch rate is compared to a desired pitch rate to determine a pitch rate correction signal that causes the pitch rate change to substantially the desired pitch rate.

32. The human transport device of claim 31, wherein the desired pitch rate is substantially equal to zero.

33. The human transport device of 26, wherein the control unit may switch between

at least a first mode and a second mode depending upon a value of a balance indicator.

34. The human transport device of claim 33, wherein the balance indicator is related to a frame pitch value, the frame pitch value representing the amount by which a center of gravity of a frame that includes at least the human transport device and a user is offset from a desired frame pitch value.

35. The human transport device of claim 34, wherein the desired frame pitch value is substantially equal to zero.

36. The human transport device of claim 26, wherein the control unit causes a transfer between at least a first mode and a second mode based upon a position of a cluster of the transport device with respect to gravity.

37. The human transport device of claim 36, wherein the control unit causes the transport device to enter the first mode if a value representing the cluster position with respect to gravity is below a lower threshold value.

38. The human transport device of claim 26, wherein the control unit causes a transfer between at least a first mode and a second mode based upon a velocity of a cluster of the transport device.

39. The human transport device of claim 36, wherein the control unit causes the transport device to enter the second mode if a value representing the cluster position with respect to gravity is above an upper threshold value.

40. The human transport device of claim 26, wherein the control unit causes a transfer between at least a first mode and a second mode based upon a velocity and a position.

41. The human transport device of claim 36, wherein the control unit causes the transport device to enter the first mode if a value representing the cluster position with respect to gravity is less than a lower threshold and causes the transport device to enter the second mode if a value representing the cluster position with respect to gravity is above an upper threshold.

42. The human transport device of claim 41, wherein the control unit, when the value representing the cluster position with respect to gravity is between the upper threshold value and the lower threshold value, causes the transport device to enter the first mode if a position of the center of gravity is near an endpoint of the cluster.

43. The human transport device of claim 41, wherein the control unit, when the value representing the cluster position with respect to gravity is between the upper threshold value and the lower threshold value, causes the transport device to enter the second mode if a position of the center of gravity is near a center point of the cluster.

44. The human transport device of claim 36, wherein the second mode includes at least two sub-modes.

45. The human transport device of claim 44, wherein the control unit causes the transport device to enter a first sub-mode of the second mode when a control switch value is greater than an entry value.

46. The human transport device of claim 45, wherein the transport device remains in the first sub-mode until the control switch value falls below an exit value.

47. The human transport device of claim 46, wherein the entry value is greater than

the exit value.

50. The method of claim 49, wherein the balance indicator is related to a frame pitch value, the frame pitch value representing the amount by which a center of gravity of a frame that includes at least the human transport device and a user is offset from a desired frame pitch value.

63. A human transport device that returns to a stable state after a disturbance has been encountered such that a human user of the device remains in an upright position comprising: a user input that receives user-desired positional input commands; and a control unit that varies the responsiveness of the human transport device to the user input commands based upon a current orientation of at least one portion of the transport device.

66. The transport device of claim 63, wherein the control unit includes a wheels controller that reduces the amount by which the user input affects rotation of at least two wheels of the transport device based upon the current orientation of the at least one portion of the transport device.

74. A method of keeping a human transport device in an upright position as the transport device traverses uneven surfaces, the method comprising steps of: receiving user inputs; determining a current orientation of at least one portion of the transport device; and selectively applying different gain coefficients to the inputs based on the current orientation of the at least one portion of the transport device.

77. A control system for controlling a human transport device comprising: a control unit that adjusts a cluster and at least one ground contacting member of the transport device such that a center of gravity of the transport device remains substantially vertically displaced over a location between end points of the cluster.

97. The system of claim 96, wherein the second mode rotates the cluster about a central cluster axis in a direction to make a longitudinal axis of the cluster substantially parallel to a surface upon which the human transport device is located.

100. A method of switching between a plurality of modes in a human transport device, the method comprising steps of: determining a first value that represents a position of a center of gravity of the transport device; and selecting between two of the plurality of modes based upon the value.

104. The method of claim 101, wherein the device is a human transporter, the first component is an electronics box of the transporter, and the first position is an angle of the electronics box with respect to gravity.

105. The method of claim 101, wherein the device is a human transporter, the first component is a movable arm of the transporter, and the first position is an angle of the movable arm with respect to gravity.

106. The method of claim 101, wherein the device is a human transporter and wherein a height of a platform capable of supporting a human is recorded also recorded in steps b) and d).

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REPRESENTATIVE-FIGURES: 1

ABSTRACT:

A class of transportation vehicles for carrying an individual over ground having a surface that may be irregular. This embodiment has a motorized drive, mounted to the ground-contacting module that causes operation of the vehicle in an operating position that is unstable with respect to tipping when the motorized drive arrangement is not powered.

[0001] This application is a divisional application of U.S. application Ser. No. 09/325,976, filed Jun. 4, 1999, which is a continuation in part of U.S. application Ser. No. 08/479,901, filed Jun. 7, 1995, now issued as U.S. Pat. No. 5,975,225,which is a continuation in part of U.S. application Ser. No. 08/384,705, filed Feb. 3, 1995, now issued as U.S. Pat. No. 5,971,091, which is a continuation in part of U.S. application Ser. No. 08/250,693, filed May 27, 1994, now issued as U.S. Pat. No. 5,701,965, which in turn is a continuation in part of U.S. application Ser. No. 08/021,789, filed Feb. 24, 1993, now abandoned.

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Summary of Invention Paragraph:
[0009] In accordance with an alternate embodiments of the invention, a method is provided for braking a vehicle having a motorized drive. The method has the steps of leaning back relative to the vehicle and using the motor to slow the vehicle in response to the leaning. In accordance with another embodiment of the invention, a method is provided for causing a vehicle having a motorized drive to move in a first fore-aft direction. The steps of the method are, first, providing an input specifying a desired motion in the first fore-aft direction, then causing the vehicle to move in a direction opposite to the first fore-aft direction in response to the input, and, finally, after the preceding step has been performed, accelerating in the first direction. Further alternate embodiments of the invention provide methods for employing each of the devices provided in the foregoing embodiments of the invention.

Detail Description Paragraph:
[0028] An alternative to operation of a statically stable vehicle is that dynamic stability may be maintained by action of the user, as in the case of a bicycle or motorcycle or scooter, or, in accordance with embodiments of the present invention, by a control loop, as in the case of the human transporter described in U.S. Pat. No. 5,701,965. The invention may be implemented in a wide range of embodiments. A characteristic of many of these embodiments is the use of a pair of laterally disposed ground-contacting members to suspend the subject over the surface with respect to which the subject is being transported. The ground or other surface, such as a floor, over which a vehicle in accordance with the invention is employed may be referred to generally herein as the "ground." The ground-contacting members are typically motor-driven. In many embodiments, the configuration in which the subject is suspended during locomotion lacks inherent stability at least a portion of the time with respect to a vertical in the fore-aft plane but is relatively stable with respect to a vertical in the lateral plane.

Detail Description Paragraph:
[0041] Another embodiment of a balancing vehicle in accordance with the present invention is shown in FIG. 2 and designated generally by numeral 24. Personal vehicle 24 shares the characteristics of vehicle 18 of FIG. 1, namely a support platform 12 for supporting subject 10 and grip 14 on handle 16 attached to platform 12, so that the vehicle 18 of this embodiment may also be operated in a manner analogous to a scooter. FIG. 2 shows that while vehicle 24 may have clusters 26 each cluster having a plurality of wheels 28, vehicle 24 remains statically unstable and, absent operation of a control loop to maintain dynamic stability, subject 10 will no longer be supported in a standing position and will fall from platform 12. In the embodiment of FIG. 2, as in the embodiment of FIG. 1, the

primary ground-contacting members are a pair of wheels. Supplemental ground-contacting members may be used in stair climbing and descending or in traversing other obstacles. In one mode of operation, for example, it is possible to rotate clusters 26 so that two wheels on each of the clusters are simultaneously in contact with the ground. Stair climbing and flat-terrain locomotion may both be achieved, however, with the vehicle supported on only a single set of primary ground-contacting members.

Detail Description Paragraph:
[0056] In order to accommodate two wheels instead of the one-wheel system illustrated for simplicity in FIG. 3, separate motors may be provided for left and right wheels of the vehicle and the torque desired from the left motor and the torque desired from the right motor can be calculated separately in the general manner described below in connection with FIG. 7. Additionally, tracking both the left wheel motion and the right wheel motion permits adjustments to be made to prevent unwanted turning of the vehicle and to account for performance variations between the two drive motors.

Detail Description Paragraph:
[0082] The pitch offset, allowing modification of {dot over (.theta.)}.sub.0, as discussed above in reference to Equation 4, may be adjusted by the user by means of thumb-wheel 32 (shown in FIG. 1). Additionally, a secondary control 34 (shown in FIG. 1) may be provided, in accordance with embodiments of the invention, for changing the control architecture or function of the thumb-wheel. Thus, thumb-wheel 32 can also be put into a mode that operates to drive both wheels in the same direction. This allows a personal mobility vehicle such as vehicle 18 to be used as sort of a powered handcart that the user trails behind her or pushes ahead of her. This is especially useful when such a personal transporter has to be carried up stairs because the motors 531 and 534 (shown in FIG. 5) are used to lift the vehicle to the next riser so that the user does not have to use as much force as would otherwise be required. This mode of operation of the vehicle is referred to as "drive mode." Additionally, upon designation by the secondary selector 34, thumb wheel 32 may be used by the user for purposes of steering the vehicle.

CLAIMS:

47. A device in accordance with any of claims 1, 6, 9, 11, 12, 14, 16, 22, or 44, further including a motorized drive arrangement controller having a first mode of operation that causes the device to leukemid and a second mode of operation that causes the device to stand substantially at a specified location.

57. A method for causing a vehicle having a motorized drive to move in a first fore-aft direction, the method comprising: a. providing an input specifying a desired motion in the first fore-aft direction; b. causing the vehicle to move in a direction opposite to the first fore-aft direction in response to the input; and c. following step (b), accelerating in the first direction.

80. A vehicle for transporting a payload over a surface that may be irregular and may include stairs, the vehicle comprising: a. a support for supporting the payload; b. a ground contacting element movable with respect to a local axis, the local axis being movable with respect to a second axis having a defined relation with respect to the support; and c. a motorized drive arrangement for permitting controllable motion of the ground contacting element with respect to the local axis in such a manner that the local axis moves with respect to the second axis so as to operate in an operating condition that is unstable with respect to tipping in at least a fore-aft plane when the motorized drive arrangement is not powered.

83. A vehicle according to claim 82, wherein the motorized drive arrangement includes at least a first actuator for rotating the ground contacting element about the local axis and at least a second actuator for causing the ground contacting

element to move in such a way that the local axis moves with respect to the second axis.

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L6: Entry 4 of 10 File: USPT Nov 25, 2003

US-PAT-NO: 6651766
DOCUMENT-IDENTIFIER: US 6651766 B2

TITLE: Personal mobility vehicles and methods

DATE-ISSUED: November 25, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
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Ambrogi; Robert R.	Manchester	NH		
Duggan; Robert J.	Northwood	NH		
Heinzmann; Richard Kurt	Francestown	NH		

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
Deka Products Limited Partnership	Manchester	NH			02

APPL-NO: 09/862839 [PALM]
DATE FILED: May 22, 2001

PARENT-CASE:
This application is a divisional application of U.S. application Ser. No. 09/325,976, filed Jun. 4, 1999, which is a continuation in part of U.S. application Ser. No. 08/479,901, filed Jun. 7, 1995, now issued as U.S. Pat. No. 5,975,225,which is a continuation in part of U.S. application Ser. No. 08/384,705, filed Feb. 3, 1995, now issued as U.S. Pat. No. 5,971,091, which is a continuation in part of U.S. application Ser. No. 08/250,693, filed May 27, 1994, now issued as U.S. Pat. No. 5,701,965, which in turn is a continuation in part of U.S. application Ser. No. 08/021,789, filed Feb. 24, 1993, now abandoned.

INT-CL-ISSUED: [07] B62D 61/00

INT-CL-CURRENT:

TYPE	IPC	DATE
CIPS	A61 G 5/14	20060101
CIPS	A61 G 5/06	20060101
CIPN	B60 K 7/00	20060101
CIPS	B62 D 57/00	20060101
CIPN	A61 G 5/10	20060101
CIPS	A61 G 5/00	20060101
CIPN	A61 G 5/12	20060101
CIPS	A61 G 5/04	20060101

US-CL-ISSUED: 180/218; 180/7.1, 180/21
US-CL-CURRENT: 180/218; 180/21, 180/7.1

FIELD-OF-CLASSIFICATION-SEARCH: 180/7.1, 180/8.2, 180/8.3, 180/65.1, 180/218, 180/21
See application file for complete search history.

PRIOR-ART-DISCLOSED:

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Search Selected | Search ALL | Clear

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ART-UNIT: 3611

PRIMARY-EXAMINER: Morris; Lesley D.

ASSISTANT-EXAMINER: Luby; Matthew

ATTY-AGENT-FIRM: Bromberg & Sunstein LLP

ABSTRACT:

A class of transportation vehicles for carrying an individual over ground having a surface that may be irregular. This embodiment has a motorized drive, mounted to the ground-contacting module that causes operation of the vehicle in an operating position that is unstable with respect to tipping when the motorized drive arrangement is not powered.

32 Claims, 16 Drawing figures

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L6: Entry 4 of 10 File: USPT Nov 25, 2003

DOCUMENT-IDENTIFIER: US 6651766 B2
TITLE: Personal mobility vehicles and methods

Application Filing Date (1):
20010522

Brief Summary Text (11):
In accordance with an alternate embodiments of the invention, a method is provided for braking a vehicle having a motorized drive. The method has the steps of leaning back relative to the vehicle and using the motor to slow the vehicle in response to the leaning. In accordance with another embodiment of the invention, a method is provided for causing a vehicle having a motorized drive to move in a first fore-aft direction. The steps of the method are, first, providing an input specifying a desired motion in the first fore-aft direction, then causing the vehicle to move in a direction opposite to the first fore-aft direction in response to the input, and, finally, after the preceding step has been performed, accelerating in the first direction. Further alternate embodiments of the invention provide methods for employing each of the devices provided in the foregoing embodiments of the invention.

Detailed Description Text (3):
An alternative to operation of a statically stable vehicle is that dynamic stability may be maintained by action of the user, as in the case of a bicycle or motorcycle or scooter, or, in accordance with embodiments of the present invention, by a control loop, as in the case of the human transporter described in U.S. Pat. No. 5,701,965. The invention may be implemented in a wide range of embodiments. A characteristic of many of these embodiments is the use of a pair of laterally disposed ground-contacting members to suspend the subject over the surface with respect to which the subject is being transported. The ground or other surface, such as a floor, over which a vehicle in accordance with the invention is employed may be referred to generally herein as the "ground." The ground-contacting members are typically motor-driven. In many embodiments, the configuration in which the subject is suspended during locomotion lacks inherent stability at least a portion of the time with respect to a vertical in the fore-aft plane but is relatively stable with respect to a vertical in the lateral plane.

Detailed Description Text (16):
Another embodiment of a balancing vehicle in accordance with the present invention is shown in FIG. 2 and designated generally by numeral 24. Personal vehicle 24 shares the characteristics of vehicle 18 of FIG. 1, namely a support platform 12 for supporting subject 10 and grip 14 on handle 16 attached to platform 12, so that the vehicle 18 of this embodiment may also be operated in a manner analogous to a scooter. FIG. 2 shows that while vehicle 24 may have clusters 26 each cluster having a plurality of wheels 28, vehicle 24 remains statically unstable and, absent operation of a control loop to maintain dynamic stability, subject 10 will no longer be supported in a standing position and will fall from platform 12. In the embodiment of FIG. 2, as in the embodiment of FIG. 1, the primary ground-contacting members are a pair of wheels. Supplemental ground-contacting members may be used in stair climbing and descending or in traversing other obstacles. In one mode of operation, for example, it is possible to rotate clusters 26 so that two wheels on

each of the clusters are simultaneously in contact with the ground. Stair climbing and flat-terrain locomotion may both be achieved, however, with the vehicle supported on only a single set of primary ground-contacting members.

Detailed Description Text (25):
In order to accommodate two wheels instead of the one-wheel system illustrated for simplicity in FIG. 3, separate motors may be provided for left and right wheels of the vehicle and the torque desired from the left motor and the torque desired from the right motor can be calculated separately in the general manner described below in connection with FIG. 7. Additionally, tracking both the left wheel motion and the right wheel motion permits adjustments to be made to prevent unwanted turning of the vehicle and to account for performance variations between the two drive motors.

Detailed Description Text (46):
The pitch offset, allowing modification of .theta..sub.0, as discussed above in reference to Equation 4, may be adjusted by the user by means of thumb-wheel 32 (shown in FIG. 1). Additionally, a secondary control 34 (shown in FIG. 1) may be provided, in accordance with embodiments of the invention, for changing the control architecture or function of the thumb-wheel. Thus, thumb-wheel 32 can also be put into a mode that operates to drive both wheels in the same direction. This allows a personal mobility vehicle such as vehicle 18 to be used as sort of a powered handcart that the user trails behind her or pushes ahead of her. This is especially useful when such a personal transporter has to be carried up stairs because the motors 531 and 534 (shown in FIG. 5) are used to lift the vehicle to the next riser so that the user does not have to use as much force as would otherwise be required. This mode of operation of the vehicle is referred to as "drive mode." Additionally, upon designation by the secondary selector 34, thumb wheel 32 may be used by the user for purposes of steering the vehicle.

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L6: Entry 8 of 10 File: USPT Dec 30, 1997

US-PAT-NO: 5701965
DOCUMENT-IDENTIFIER: US 5701965 A

TITLE: Human transporter

DATE-ISSUED: December 30, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
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Heinzmann; Richard K.	Francestown	NH		
Key; Brian R.	Pelham	NH		
Skoskiewicz; Andrzej	Manchester	NH		
Kristal; Phyllis K.	Sunapee	NH		

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
Deka Products Limited Partnership	Manchester	NH			02

APPL-NO: 08/250693 [PALM]
DATE FILED: May 27, 1994

PARENT-CASE:
This application is a continuation in part of U.S. application Ser. No. 08/021,789, filed Feb. 24, 1993, now abandoned, which is hereby incorporated herein by reference.

INT-CL-ISSUED: [06] B62D 61/12

INT-CL-CURRENT:

TYPE	IPC	DATE
CIPS	A61 G 5/06	20060101
CIPS	A61 G 5/00	20060101
CIPS	A61 G 5/04	20060101
CIPN	A61 G 5/10	20060101
CIPS	A61 G 5/14	20060101
CIPN	B60 K 7/00	20060101
CIPS	B62 D 57/00	20060101

US-CL-ISSUED: 180/7.1; 180/6.5, 180/8.2, 180/21, 180/65.8, 180/907, 280/5.26, 364/176, 364/463

US-CL-CURRENT: 180/7.1; 180/21, 180/6.5, 180/65.8, 180/8.2, 180/907, 280/5.26, 700/71, 701/124

FIELD-OF-CLASSIFICATION-SEARCH: 180/7.1, 180/8.2, 180/8.3, 180/8.5, 180/8.6, 180/65.1, 180/65.8, 180/907, 180/118, 180/6.48, 180/6.5, 180/6.54, 180/41, 180/21, 901/1, 364/176, 364/463, 364/424.05, 364/424.06, 364/434, 280/5.2, 280/5.26, 280/5.28, 280/5.32, 280/6.1, 280/205, 280/DIG.10
See application file for complete search history.

PRIOR-ART-DISCLOSED:

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Vos et al., "Dynamics and Nonlinear Adaptive Control of an Autonomous Unicycle--Theory and Experiment", American Institute of Aeronautics and Astronautics, A90-26772 10-39, Washington, D.C. (1990), pp. 487-494 (Abstract only).

ART-UNIT: 316

PRIMARY-EXAMINER: Boehler; Anne Marie

ATTY-AGENT-FIRM: Bromberg & Sunstein LLP

ABSTRACT:

There is provided, in a preferred embodiment, a device for transporting a human subject over ground having a surface that may be irregular and may include stairs. This embodiment has a support for supporting the subject. A ground-contacting module, movably attached to the support, serves to suspend the subject in the support over the surface. The orientation of the ground-contacting module defines fore-aft and lateral planes intersecting one another at a vertical. The support and the ground-contacting module are components of an assembly. A motorized drive, mounted to the assembly and coupled to the ground-contacting module, causes locomotion of the assembly and the subject therewith over the surface. Finally, the embodiment has a control loop, in which the motorized drive is included, for dynamically enhancing stability in the fore-aft plane by operation of the motorized drive in connection with the ground-contacting module. The ground contacting module may be realized as a pair of ground-contacting members, laterally disposed with respect to one another. The ground-contacting members may be wheels. Alternatively, each ground-contacting member may include a cluster of wheels. In another embodiment, each ground-contacting member includes a pair of axially adjacent and rotatably mounted arcuate element pairs.

L6: Entry 8 of 10 File: USPT Dec 30, 1997

DOCUMENT-IDENTIFIER: US 5701965 A
TITLE: Human transporter

Application Filing Date (1):
19940527

DATE ISSUED (1):
19971230

Drawing Description Text (12):
FIGS. 9-10 show use of a two-wheel cluster design in various positions;

Detailed Description Text (12):
In order to accommodate two wheels instead of the one-wheel system illustrated in FIG. 6, the torque desired from the left motor and the torque desired from the right motor can be calculated separately in the general manner described below in connection with FIG. 33. Additionally, tracking both the left wheel motion and the right wheel motion permits adjustments to be made to prevent unwanted turning of the device and to account for performance variations between the two drive motors.

Detailed Description Text (22):
In FIG. 9, there is shown a side view of an embodiment utilizing a two-wheel cluster design. The subject 962 is shown supported on the seat 95 of this embodiment. In view is the right-hand cluster 91 with a pair of wheels 931 and 932 in radially symmetric locations about the cluster's axis 92 of rotation. A similar left-hand cluster is also employed. Each cluster has its own separately controlled motor to drive it about its axis of rotation 92. Each pair of wheels (here, 931 and 932) is also driven by a separately controlled motor about its own axis of rotation, but the wheels of a cluster are coupled to rotate synchronously.

Detailed Description Text (25):
FIGS. 11-18 show use of a three-wheel cluster design in various modes and configurations. FIGS. 11 (showing stable rest position) and 12 (showing balancing position for travel) for three-wheel clusters correspond to FIGS. 9 and 10 for two-wheel clusters. Each three-wheel cluster (right-hand cluster 111 is shown here) is rotatably mounted and motor-driven about axis 112, using separately controllable motors. As in the case of the two-wheel cluster design, the wheels of each cluster are separately driven and controlled, but run synchronously in each cluster.

Detailed Description Text (65):
FIGS. 39A-B, 40A-B, 41A-B, and 42A-C illustrate the sequences in a control arrangement, to permit a device according to the embodiment of FIGS. 11-21 to achieve stair climbing in accordance a second embodiment. Four basic sequences of operation are involved in this embodiment: start; reset angle origins; transfer weight; and climb. This embodiment, among others, may be conveniently implemented in the control arrangement of FIG. 27. Block diagrams showing control algorithms for achieving these four sequences are shown in FIGS. 43 (start), 44 (transfer weight), and 45 (climb). (No motion is involved in the reset angle origins sequence, so no control algorithm is shown for this sequence.) FIGS. 39A and 39B illustrate orientation of the cluster in the start sequence. In this sequence, the

cluster moves from its normal balancing position on two wheels (FIG. 39A) to a position (shown in FIG. 39B) in which a first pair of wheels (one from each cluster) is on a first level and a second pair of wheels from each cluster is on the next stair. The angle values used in this description in connection with FIGS. 39A through 42C are those resulting from application of the nominal stair and cluster wheel sizes given in Table 1 above. In the start sequence, algorithm shown in FIG. 43, an input is provided of .theta..sub.C ref as a function of time to the cluster block 4301; the function varies smoothly from the start to the finishing values. Alternatively, an input of .theta..sub.PC ref can be provided in a similar fashion. Here the input of .theta..sub.C ref is run through processor 4302 to compute the quantity ##EQU2## This quantity, along with .theta..sub.C ref itself and .PI. are provided as inputs to summer 4303, which computes ##EQU3## and provides this quantity as the .theta..sub.PC ref input to cluster block 4301. The cluster block 4301 is configured as in FIG. 34, except that .theta..sub.PC ref is no longer fixed at .PI., but varies as just described. The balancing block 4304 is configured as in FIG. 33, but the joystick gains K10 and K11 are set to 0. The summer 4305 provides compensation to the pitch reading of the inclinometer in the same manner as described above in connection with FIG. 35, and the output of summer 4305 is differentiated by differentiator to provide correction of .theta..sub.I in the manner described above in connection with FIG. 35, so corrected pitch inputs .theta. and .theta. are provided to the wheel balancing algorithm 4304. The inputs r.theta..sub.wl and r.theta..sub.wr to balancing block are also derived in the same manner as described above in connection with FIG. 35.

CLAIMS:

13. A device according to claim 3, further comprising:

drive control means, including the control loop, for driving the support members in a first mode wherein a first arcuate element in each group of axially adjacent arcuate elements generally remains in contact with the ground up to a point near in arcuate distance to where the next succeeding arcuate element comes in contact with the ground, and so on as successive arcuate elements come in contact with the ground, so as to provide substantially continuous rolling motion of the device along the arcuate elements.

14. A device according to claim 13, wherein the drive control means includes means for driving the support members in a second mode to permit ascent and descent of stairs and other surface features.

19. A device according to claim 17, wherein each cluster has two wheels of substantially equal diameter.

26. A device according to claim 21, further comprising:

coordination control means for coordinating operation of the cluster control means with that of the wheel control means, the coordination control means having a stair climbing mode to cause steps as follows:

(1) start, in which the assembly, balanced on a first wheel pair, one from each cluster, is disposed adjacent to a stair and the clusters are then rotated so that a second wheel pair is resting on the stair;

(2) transfer weight, in which the weight of the device and the subject is transferred from the lower first wheel pair to the second wheel pair on the stair by motion of the clusters relative to the assembly while the wheels are driven to maintain the position of the clusters relative to the world;

(3) climb, in which the second wheel pair is driven to move the device forward to the riser of the succeeding stair while simultaneously the clusters are driven to

position the next wheel pair on the tread of the succeeding stair, this step being carried out while the wheel control means is in the balance mode;

and wherein steps (2) and (3) are alternated until the last stair, at which point normal balance mode of the wheel control means is entered into.

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